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Mt. Graham Archaeological Project:
Survey Report for the 1999 Field Season

by

Warren K. Lail

with contributions by
Christopher C. Brooks

A Report Prepared For
The Coronado National Forest
Tucson, Arizona

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Acknowledgements

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By

Warren K. Lail

Introduction

Over time, prehistoric peoples throughout the world experienced fundamental changes at the most basic levels of existence, including subsistence, settlement, technology, and social organization (Earle 1980; Flannery 1972). Although these changes took place at different times and in different environments, in the end the results were often quite similar. Most people eventually decreased their movements across the landscape and began to live in more permanent settlements (Parry and Kelly 1987). In addition, they reduced the degree to which they depended upon wild plants and animals for food and began to rely more heavily upon domesticated plants (Wills 1992; Wills and Huckell 1994). In many cases the transition was gradual (Minnis 1992; Whalen 1994), and non-synchronous among sub-regions (see Fish 1989; Fish et al. 1992; Gilman 1997).

Technologies also changed in response to new subsistence and social practices and as the causal factors that facilitated them (Alexander 1977; Earle 1980; Lail 1999). Social organization also underwent change, often as a primary causal factor for, and sometimes as a result of, shifts in other cultural practices (Dobres and Hoffman 1994). Although in some cases the changes in subsistence and settlement practices, technology, and social organization may have come about gradually, in other instances they may have occurred more abruptly, with the rate of change likely related to a broad array of causal

factors. Apart from of causation or rate of change, however, we eventually see an overall decrease in the number of supposedly egalitarian societies and a corresponding increase in the number of complex social forms (Tainter 1996). The end result is that most societies eventually came to look and function radically different than during all preceding periods of human history. When these changes are considered in their totality, perhaps no human transformations have been so great as these, nor their effects so widely felt.

The same mechanisms that affected the rest of the world were also at work in the deserts of the American Southwest. Here, many of the dramatic changes in the human condition occurred during the transition period between the Late Archaic and Pit Structure Periods (1500 B.C. to A.D. 1050). Evidence from the region indicates that a hunting-foraging subsistence economy persisted for some time before giving way to a farming-hunting-foraging regimen. However, it appears that shifts in settlement and subsistence practices occurred without regularity over space or through time (see Fish 1989; Fish et al. 1992; Gilman 1995, 1997, 1998). For example, Wills (1992) suggests that evidence of agriculture – maize – first appears in the Southwest in west-central New Mexico and east central Arizona at around 1100 B.C. Similarly, Fish et al. (1992) recorded substantial archaeological evidence to support their argument that people in the Tucson Basin were living in settled villages and dependent upon agriculture as early as the Late Archaic.

On the other hand, Gilman's (1995, 1997, 1998) research in the San Simon Basin suggests that people there, although living in an environment similar in many respects to that of the Tucson Basin, continued to move about the landscape (residential mobility)

and engage in hunting and foraging (logistical mobility) as a means of subsistence well into the Pit Structure period (A.D. 100 to 1050). Moreover, Gilman (1997) suggests that people in the San Simon drainage did not become wholly dependent upon agriculture, nor did they fully settle into permanent villages, until after A.D. 1050. She believes (1998:3) that the shift to decreased residential mobility and increased agricultural dependence can best be described as a "long, slow trajectory." However, Lail (1999), after examining stone tool evidence from six sites in the San Simon Valley, found statistically significant evidence to support an argument for decreasing mobility, together with evidence of increasing plant processing between the Late Archaic and the Pit Structure periods, suggesting that the transition may have occurred earlier rather than later.

Conflicting evidence leaves the finer details of regional settlement and subsistence largely unsettled. How and when people changed the ways in which they lived, and how they used the landscape and its resources through time, continues to provide fodder for scholarly research. Conflicting evidence is not inherently bad. It serves as a catalyst to keep researchers ever vigilant for the subtlest of clues in our ongoing attempts to understand differences in the regional archaeological record. Moreover, conflicting evidence serves to keep the debate alive which may open the way for an overall better understanding of the settlement and subsistence strategies employed by prehistoric Southwesterners.

One way to address the issue of late or continuing mobility in the San Simon drainage is to examine data from nearby resource procurement areas like Mt. Graham. While conducting a survey for knappable quartzite cobbles in the San Simon drainage[1], I

[1] Conducted as part of my M.A. research at the University of Oklahoma. Funded in part by the Oklahoma Museum of Natural History.

questioned whether the Late Archaic (1500 B.C. to A.D. 100) to Early Pit-structure (A.D. 100 to A.D. 650) period residents of the drainage would have made seasonal use of the large bajada slopes on the broad eastern face of nearby Mt. Graham. During an ensuing conversation with Dr. William Gillespie, archaeologist with the Coronado National Forest, a further question arose as to the actual season the slopes would have seen use, if any. I suggested that summer use was more likely because the mountain slopes offered permanent water, lower ambient temperatures, a wide variety of game, and a diverse range of plant resources. Moreover, several broad, flat areas on and between the alluvial fans could be incorporated into an early agricultural scheme, if one existed, even if the growing season were somewhat short.

Dr. Gillespie, on the other hand, suggested that the most likely season of use, if any, would be the fall and winter. He reasoned that piñon nuts would be available in the fall, and that game would also be plentiful during that time. Of course, it is possible that the area was used during multiple seasons, including summer and fall, but survey data were needed to determine whether Late Archaic/Early Pit-structure peoples used the area at all. Accordingly, the purpose of this research project was to determine who was using the mountain's resources, during what season (or seasons), and why? Moreover, how did conditions in the San Simon drainage, possibly combined with those on the eastern slopes of Mt. Graham, differ from the Tucson Basin in such a way as to create an environment that supported hunting, foraging, and seasonal residential movements well into the first millennium A.D. as suggested by Gilman (1997)? Would stone tool evidence support or refute Lail's (1999) suggestion that local people were moving less, hunting less, and increasingly relying upon agricultural resources through time between the Late Archaic

Accordingly, elevation is more of a significant factor for hydrology and vegetation than is latitude.

Geology and Geomorphology

Mt. Graham creates a large portion of the western boundary of the San Simon Valley. The valley itself trends southeast-northwest and is situated in the Basin and Range physiographic province (Nations and Stump 1981; Figure 2). Looking east from Mt. Graham across the San Simon drainage one sees the Peloncillo and Whitlock Mountains. A view to the south reveals the Dos Cabezas and Chiricahua Mountains. All of the nearby mountains and mountain ranges are tilted and heavily eroded block-fault formations dating from the Precambrian to the Cenozoic (Nations and Stump 1981).

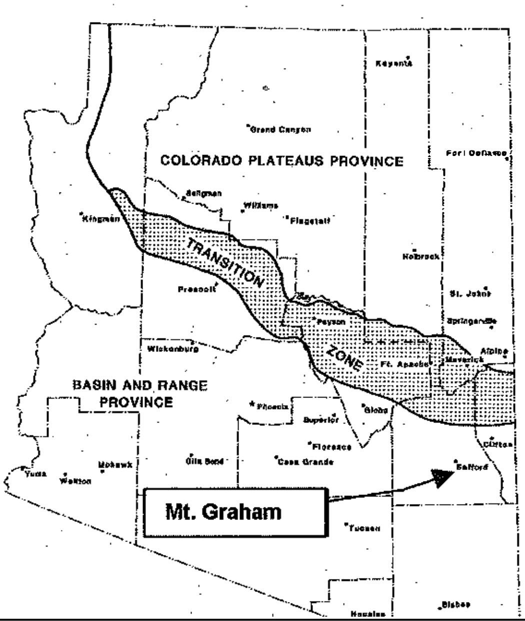


Figure 2. Arizona's physiographic provinces. Adapted from Nations and Stump (1981).

The San Simon Valley is about 2,900 feet in elevation at its lowest point. It is a deep sedimentary basin filled by the movement of debris from high-angle faults, resulting in alluvial valley-fill thousands of feet deep, composed mostly of gravel, sand, and silt of Cenozoic age, and by detrital materials from the surrounding Mesozoic volcanic episodes (Houser et al. 1985; Nations and Stump 1981; Figure 3).

The valley floor gives way to Mt. Graham in a gentle fashion due to the presence of large alluvial fans, or delta-shaped masses of sand, gravel and silt that are deposited by runoff. In places, the alluvial fans coalesce laterally to form bajadas. Between some

bajadas colluvial valleys have formed where in at least one instance the prehistoric inhabitants of the area terraced and fully irrigated the area (Area B, Site 3).

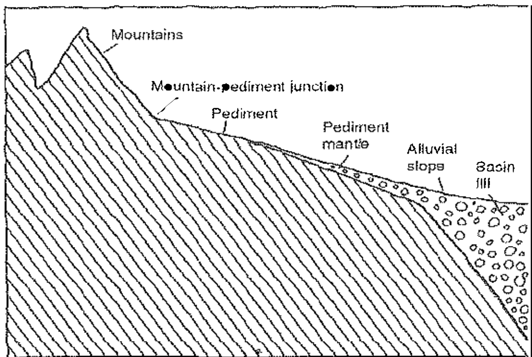


Figure 3. Idealized valley cross-section.

The Peloncillo and Whitlock mountains to the east primarily consist of extrusive volcanic materials, including Pliocene to middle Miocene silicic and mafic flows and pyroclastic rocks that include basalts, andesites, and rhyolites (Cooley et al. 1967; Reynolds 1988). The Pinaleño Mountains, including Mt. Graham, are composed primarily of plutonics, including granite, schist, and gneiss of Precambrian age (3000 m.y. old[2]), although several small basalt sills are present on the mountain. Like the Pinaleños, the Dos Cabezas to the south are composed primarily of Precambrian schist, gneiss and granite, along with several more recent igneous intrusions (Cooley et al. 1967). Further south, the Chiricahua Mountains are composed of andesite, rhyolite, latite and dacite flows, together with a small body of Permian to Cambrian age (600 to 250 m.y. old) sedimentary materials, known to geologists as the Escabrosa Limestone Formation (Cooley et al. 1967). Intermittent groupings of Carboniferous and Devonian quartzites may also be found along the eastern edge of the Chiricahuas (Forrester 1959).

Because the mountains to the east formed from different processes, they produced geologic materials that are distinct from those found on the eastern slopes of Mt. Graham, and so it is relatively easy to determine which materials occur naturally and which have been carried upslope by humans for use as tool making materials. Indeed, the survey

[2] Millions of years old.

confirmed the presence of a variety of non-native rocks that were carried upslope for just this purpose.

Hydrology

The San Simon River is a north-draining tributary of the Gila River. While it lies empty most of the year, the San Simon River flows during periods of heavy rainfall in the monsoon season (early July through mid-August). In the past it may have flowed perennially with fluctuations throughout the year, and thus could have supported more plant life than today (Dobyns 1981). The present-day San Simon Valley is hot and dry with summer daytime high temperatures often exceeding 110° F (Brown 1994).

As much as 12 feet of snow may accumulate on the summit of Mt. Graham during the winter season, providing a dependable source of moisture throughout the spring and early summer. Thereafter, spring snowmelt is replaced by heavy and regular rainfall throughout much of the summer. Jacobson Creek is a perennial stream with its headwaters high on the slopes of Mt. Graham. It flows down Mt. Graham's eastern face directly through the study area.

Vegetation

Mt. Graham is home to a wide variety of plants that are largely elevation dependent. Between 3,500 feet and 6,000 feet, one finds cacti, including large prickly pear, cholla, and ocotillo, and also creosote bush, acacia, yucca, and mesquite. At higher elevation a transition gradually takes place with lowland desert vegetation giving way first to piñon pines and junipers, then to ponderosa pines and oaks. Even higher one sees spruce, aspen, and fir trees together with a variety of ferns and grasses. In contrast, the

San Simon Valley is host to creosote bush, saltbush, snakeweed, mesquite, and burrobush, together with a several other desert species (Gilman 1997).

Regional Chronology

The Archaic Period (9000 B.C. – A.D. 100)

The Cochise culture is the major Archaic manifestation in southeast Arizona (Bronitsky and Merritt 1986). Cochise culture occupation is broken into the Sulphur Springs stage (9000-3500 B.C.), the Chiricahua stage (3500-1500 B.C.), and the San Pedro stage (1500 B.C to A.D. 100). Taken together these periods witnessed an increase in dependence upon gathering and also the introduction of grinding tools, including shallow basin milling stones (Bronitsky and Merritt 1986).

The Pit Structure Period (A.D. 100 to 1050)

Much recent research in the San Simon Valley (Gilman 1987, 1992, 1995, 1997, 1998) focuses upon the transition period between the Late Archaic and the Pit Structure periods. Gilman suggests that during this time, shifts in mobility and agricultural dependence occurred, although very gradually. Gilman (1997) sub-divided the Pit Structure period into the Early, Middle and Late periods based upon pottery types. Early Pit Structure period (A.D. 100 to 650) pottery is plain brown ware until about A.D. 400, and thereafter sees the addition of red ware between A.D. 400 and A.D. 650 (although brown ware persist throughout most time periods) (Gilman 1997). The larger, village-type site occupations begin to appear near the end of this period; of particular of note are Timber Draw and San Simon Village (Gilman 1997). The Middle Pit Structure period (A.D. 650 to 900) sites begin to show evidence of red-on-brown painted ware, as well as

Mimbres black-on-white and buff wares, although both occur in low frequencies (Gilman 1997). Finally, the Late Pit Structure period (A.D. 900 to 1050) is characterized by the continuation of painted wares of several varieties (Mimbres black-on-white, Hohokam red-on-buff, and San Simon red-on-brown wares) in increasing frequencies (Gilman 1997).

The Surface Structure Period (A.D. 1050 to 1150)

The Surface Structure period is characterized by structures distinct in design from earlier pit houses. These sites often contain only single surface rooms outlined by cobbles and generally contain higher frequencies of Mimbres Classic black-on-white and Encinas red-on-brown varieties, as well an increase in the frequency of corrugated wares when compared to earlier periods (Gilman 1997:28-31).

The Post-A.D. 1150 Period

Little evidence exists for intensive use of the San Simon Valley after A.D. 1150. However, Mt. Graham became increasingly important during the post-A.D. 1150 period as witnessed by the Marijilda Pueblo site and other Salado occupations. Also in the post-A.D. 1150 time period the area adjacent to the Gila River near Safford saw an increase in use as evidenced by the pueblo occupations there (Gilman 1997).

Methodology

The survey area was selected based upon an assessment of the hydrology and topography of the bajada slopes. Large, relatively flat areas near Jacobson Creek were selected for examination. Thereafter, the general survey area was broken into several sub-areas, each receiving an arbitrary designation (A, B, C and D) based upon sequence

of survey (no sites were recorded in Areas C and D). We originally intended to survey in 10-meter transects throughout, typically north-south in orientation. Area A, having been recently cleared by a Forest Service controlled burn, was thoroughly examined by this method. However, sections of Areas B, C, and D, were heavily overgrown with head-tall prickly pear, thick cats-claw acacia, and up to three-meter tall mesquite. Accordingly, in certain instances we reduced our transects to five meters in order to ensure survey integrity. Pin flags and flagging tape were employed along the margins of each transect to make sure all areas were covered fully.

All but one of the MGAP participants came to the project with previous archaeological field experience. Generally those with more experience were placed in strategic positions in order to be able to supervise lesser-experienced members of the team and to answer questions as they arose.

When we located a site, Global Positioning System (GPS) coordinates (SA-degraded) were recorded for the site generally, as well as for each artifact collected. Because some of the sites were expected to date to the Late Archaic and thus be very ephemeral in nature, a substantial surface collection could conceivably have had the same impact as a more invasive excavation. Accordingly, we made ours a minimal impact survey and collected only diagnostic artifacts, and even then in very limited quantities.

Each artifact we collected was placed in a protective (archival) plastic zipper bag with an identifying label containing full provenience data. Later, all artifacts were carefully washed and dried, placed in new zipper bags, and assigned Field Specimen (FS) numbers.

Survey Areas, Site Locations and Descriptions

Survey Area A

Site A1, Rattlesnake Point AR03-05-04-216

Area A is located on the Mt. Graham topographic quadrangle. Only one site was located in this area. We named it Rattlesnake Point in honor of two aggressive Mojave rattlers residing there. Rattlesnake Point is located at UTM 12S, 614843E, 3617716N (SA-degraded) at 4,804 feet in elevation and depicted on the Mt. Graham USGS quadrangle map (Figure 4).

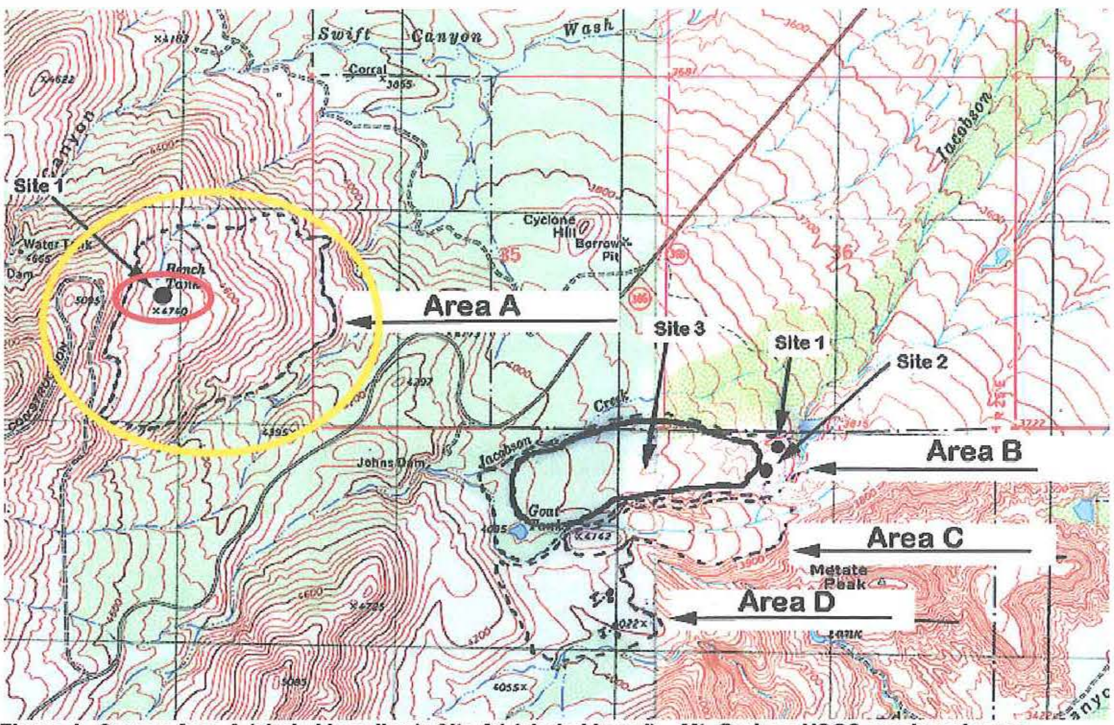


Figure 4. Survey Area A (circled in yellow); Site A1 (circled in red). Mt. Graham USGS quadrangle map.

Architecture

Several structures were observed at Rattlesnake Point, each built of tabular stones (granite-gneiss) with walls ranging from .5 to 1 meter tall (Figures 5, 6). The structures

Figure 5. Main structure, Area A, Site 1.

Figure 6. Secondary structure, Area A, Site 1.

range in size from 2 meters to 3.5 meters in diameter. The most substantial structure is enclosed on three sides and fashioned in a sort of west-facing horseshoe configuration (Figure 5).

Lithics

In and near the structures at Rattlesnake Point we found several fairly dense lithic scatters consisting of primary, secondary, and tertiary flakes, together with several projectile points. Materials include gray meta-quartzite, deep red rhyolite, latite, and obsidian (Figure 7).

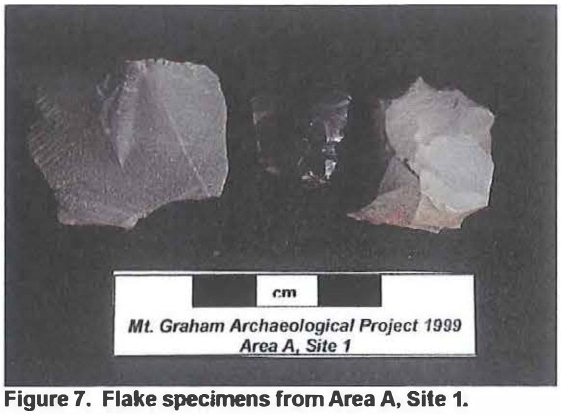


Figure 7. Flake specimens from Area A, Site 1.

The obsidian projectile point (Figure 8) is about 1.5 cm long with convex sides, produced without a stem, and is similar in appearance to a Middle Archaic (5000 to 1500 B.C.) Pinto style projectile (Sliva 1997). The triangular rhyolite projectile point (Figure 9) appears to be a Cienega variety point, possibly a Cienega 2, and probably dates to

approximately A.D. 400 (Sliva 1997). The materials from which these projectiles were made do not occur naturally on the slopes of Mt. Graham, but do occur within the San Simon Valley itself. Although rhyolite is fairly plentiful within the San Simon Valley, there are no point sources for the obsidian in the immediate area. However, small nodules (Apache tears) do occur in several drainages within the San Simon Valley (Gilman and Shackley 1999).

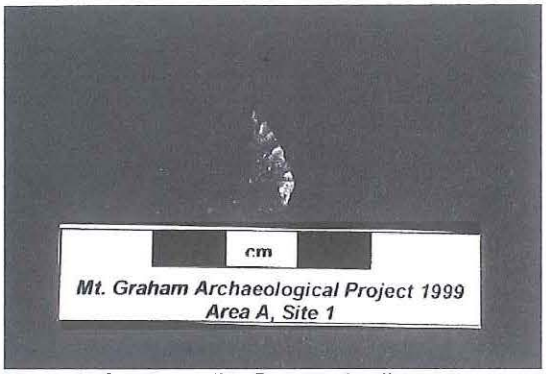


Figure 8. Small possible Pinto projectile point.

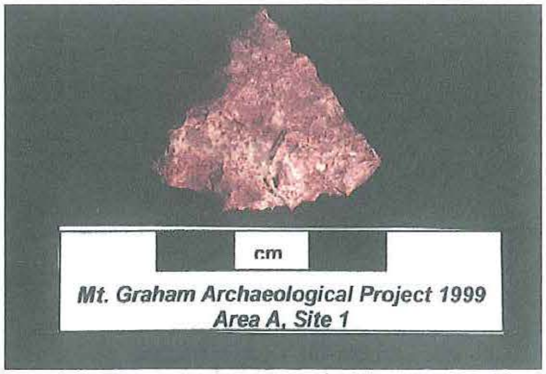


Figure 9. Triangular rhyolite projectile.

Ceramics

Several light scatters of plain brown sherds are present at the site, mainly within the structure boundaries. In addition, several sherds were found down slope (east) of the site (Figure 10). One plain brown corrugated jar rim sherd was also located within one of the structures. Six plain brown sherds and one corrugated jar rim sherd were collected from the site (Appendix B).

Figure 10. Plain brown sherds from Area A, Site 1.

Features

No features were observed on the site itself. However, three rock cairns were observed nearby. The cairns are between .5 to 1.0 meter tall and form a line roughly east-west in orientation, spaced approximately 50 meters apart.

General Comments

The Rattlesnake Point site is in good condition. The soil appears to be stable with very little erosion. At the time of the survey vegetation was almost entirely absent (due to a recent Forest Service controlled burn) and visibility was near one hundred percent. The site does not appear to have been vandalized and appears mostly intact. Several historic artifacts were observed nearby; one horseshoe and several old tires are upslope to the west near an area of road construction.

Overall, the site appears to have good research potential. Our initial observations lead us to believe that Rattlesnake Point was a limited-use site, likely related to resource extraction and, based upon projectile point and pottery types, probably dates to the Late Archaic or Early Pit Structure periods (1500 B.C. to A.D. 650), and may have seen use even earlier during the Middle Archaic. Because the site is in relatively good condition with little erosion, we are hopeful that one of the structures will contain a hearth that may enable us to obtain a radiocarbon date as well as recover botanical samples to help determine season of use.

Survey Area B

Site B1 – The Highpoint Site AR03-05-04-217 (FS)

Three sites were located in Survey Area B. Site B1, the Highpoint site, is located at UTM 12S, 617530E, 3617078N (SA-degraded) at approximately 3,800 feet in elevation and depicted on the Artesia USGS quadrangle map (Figure 11).

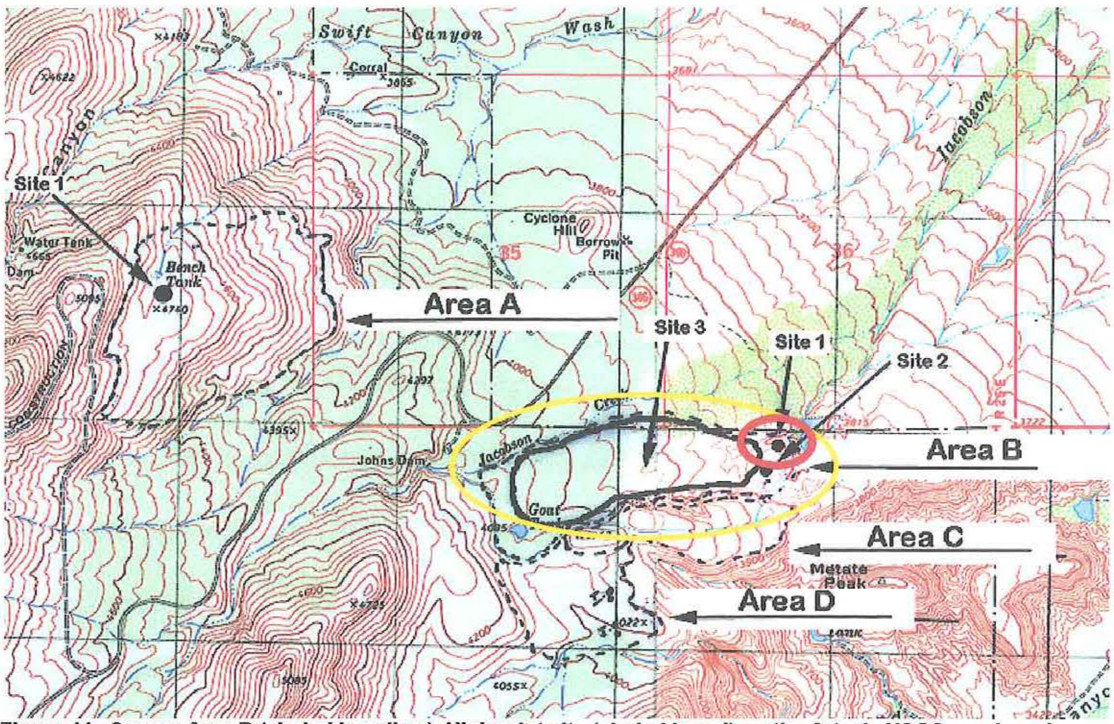


Figure 11. Survey Area B (circled in yellow), Highpoint site (circled in red) on the Artesia USGS quadrangle.

Architecture

No surface structures were observed at the Highpoint site. However, several depressions were visible on the surface, suggestive of the presence of at least two pit houses (Figure 12). A tall (5 meter) natural mound, the highest point on the site, located just north of the surface depressions, possesses a moderate sized stone circle at center top, likely a hearth, but no evidence of a structure was found on the mound itself (Figure 13).

Figure 12. Shallow depression, possibly a pit house.

Figure 13. Stone circle atop mound.

Lithics

Flakes are scattered in fairly heavy concentrations about the site, with the highest concentrations in and near the depressed areas. These included primary, secondary, and tertiary flakes of latite, highly metamorphosed quartzite, granite-gneiss and quartz, along with some basalt. In addition, one chalcedony flake tool was found on the surface inside one of the depressed areas (Appendix B).

Ceramics

The site also contains a very dense concentration of pottery sherds. Plain, corrugated, and painted wares comprise the assemblage, including Mimbres Black-on-white, Encinas Red-on-brown, Sacaton Red-on-buff, and Red wares (Figures 14-17). A total of twenty-six sherds were collected from this site (Appendix B).

Figure 14. Mimbres Classic. Area B, Site 1.

Figure 15. Sacaton Red-on-buff w/ Gila shoulder

Figure 16. Encinas Red-on-brown, Site B1.

Figure 17. Pinaleño Red-on-brown, Site B1.

Features

A potential hearth atop the mound, mentioned previously, was the only feature observed at the site. Several pieces of fire-cracked rock were observed just to the east of the rock circle, but slightly down slope.

Groundstone

Several small metates were observed on the site, mostly scattered about east of the surface depressions. Several are made of vesicular basalt, but one is made of what appears to be a granite-gneiss material, and has a mano sitting on its edge (Figure 18). The size of the metates, combined with the small manos found in the same contexts, suggests that heavy maize processing was not taking place at this site.

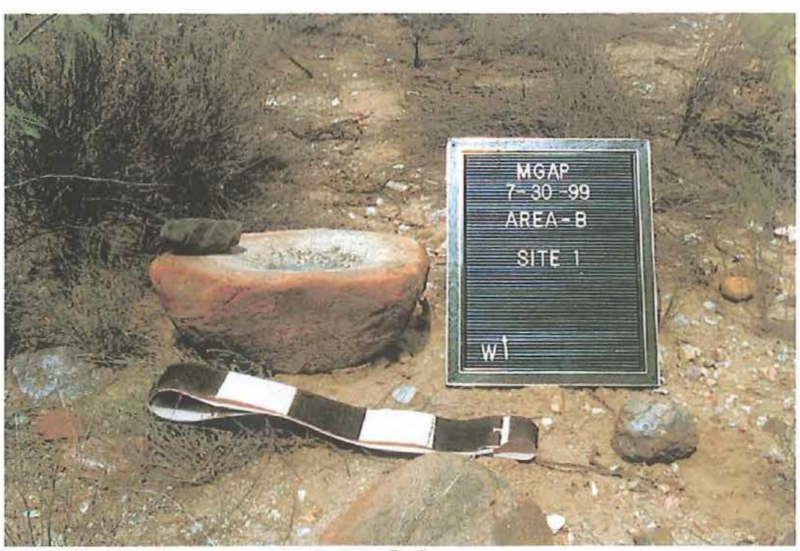


Figure 18. Granite-gneiss metate, Area B, Site 1.

General Comments

Pothunters have tested several areas of the site, but little damage appears to have been done. None of the looter's holes are severely invasive; most are only about twice the width of a shovel, approximately 20 cm in depth and approximately 30 cm in length. Erosion is a problem near the north and west margins of the site where several large arroyos have cut into the site. It also appears that a portion of the site has been damaged by the digging of a canal by later inhabitants of the area, most likely the Salado period occupants of Area B, Site 3 (The Little Manhattan site). The majority of the ceramics present suggest that the Highpoint site dates to the Middle-to-Late Pit Structure periods (A.D. 650 to 1050).

Research potential for this site is good. However, erosion will soon become a significant factor that will contribute to the degradation of a portion of its western edge. Rodent damage is evident in the form of several packrat middens, but it is not excessive.

Site B2 – The Mano Site AR03-05-04-218 (FS)

The Mano site is located at UTM 12S, 617485E, 3616954N (SA-degraded), at approximately 3,800 feet in elevation. This site is depicted on the Artesia USGS quadrangle (Figure 19). Eight small manos were observed on the site, hence the name (Figure 20). This site is located about 100 meters south and west of Site B1 (Area B, Site 1). A large arroyo separates the sites today, but it is possible that the two sites were at one time part of a single large site.

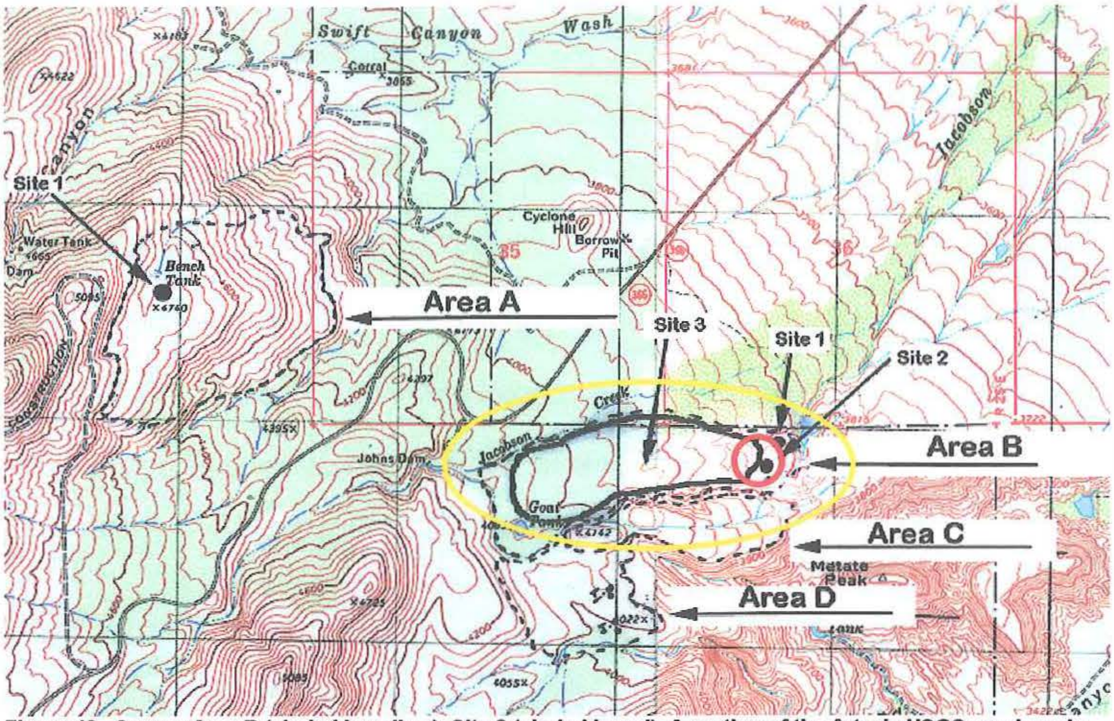


Figure 19. Survey Area B (circled in yellow), Site 2 (circled in red). A portion of the Artesia USGS quadrangle.

Figure 20. Group of manos on Site B2.

Figure 21. Large depression on Site B2.

Architecture

On site B2 (Area B, Site 2), one large (4m diameter) depression is apparent on the surface. Rocks protruding from beneath the surface suggest the presence of a fairly large pit house (Figure 21, above right). What appears to be a prehistoric canal, presumably associated with Site B3, severs the site on the south end, and possibly invades another depressed area.

Lithics

Primary, secondary, and tertiary flakes are present over much of the site area. Lithic density is relatively low on this site when compared to Site B1 only 100 meters away. However, the concentration is heaviest near the center depression. A single unifacial flake tool made of rhyolite was collected (Figure 22), although a variety of other materials are present on the site, including latite and very fine-grained quartzite.

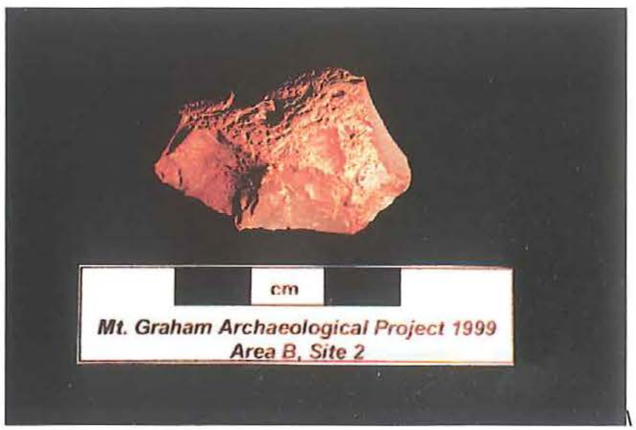


Figure 22. Rhyolite flake tool, Area B, Site 2.

Ceramics

Although this site contains a fairly dense concentration of ceramics, we collected only eleven sherds for analysis. These included two plain brown wares and several sherds that appeared to be Playas incised (Figure 23).

Figure 23. Playas incised sherds from Area B, Site 2.

Groundstone

Eight manos were observed within an area about 1.5 meters in diameter. All of them are small and of the one-hand variety (Figure 20, above). No metates were found on this site.

Features

No features are associated directly with this site. However several Salado agricultural features, a canal and several terraces, encroach somewhat on the site. The canal cuts through the south end of the site, while the terraces are to the north and west of the site, down slope, and presumed to be part of the very large Salado occupation nearby (Area B, Site 3).

General Comments

This site, like Site B1, holds good research potential because of the presence of what appears to be a pit house within its boundaries. However, the site has been subjected to considerable erosion, being bounded on three sides by deep arroyos. Given the erosion damage and the damage caused by the canal, the site is in some jeopardy of being lost, even though the potential pit house appears to be safe from erosion for some time because of its position near the center of the site. There are no visible signs of looting at this site.

The absence of evidence of intensive maize processing, combined with the similarities between the artifacts on this site and the nearby Highpoint site, leads us to conclude that the site dates to the Pit Structure period and that the two sites are probably contemporaneous. The site was possibly related to resource extraction, but the season or seasons of use are unknown. The Mano site should be excavated, stabilized, or tested

within the next several years in order to extract the information it holds about the prehistoric inhabitants of the mountain slope.

Site B3 – Little Manhattan AR03-05-04-219 (FS)

Area B, Site 3 (the Little Manhattan site) is located at UTM 12S, 616827E, 3617124N (SA-degraded) (Figure 24). The site's lowest point, to the east, is at or near 3,800 feet and its highest point, to the west, at or near 4,050 feet in elevation.

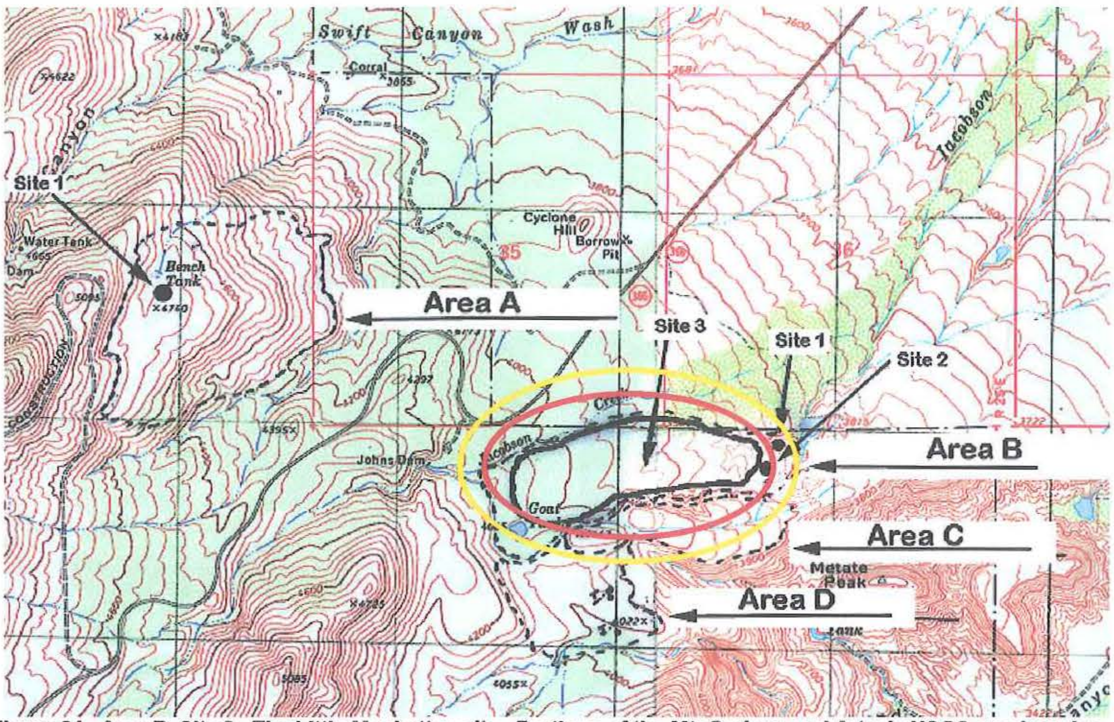


Figure 24. Area B, Site 3. The Little Manhattan site. Portions of the Mt. Graham and Artesia USGS quadrangles.

Little Manhattan is a very large agricultural site approximately 1 km in length (east to west) and approximately .5 km in width (north-south), and it occupies a large colluvial valley. The terrain is generally quite rocky, but large areas have been cleared for agricultural purposes.

Architecture

Eight surface structures were observed on this site, including one large two-room structure. The structures are not contiguous, but instead dispersed throughout the site area generally among the many terraces, canals, and check dams. Most structures range in size from one to two meters square.

Lithics

Lithics are abundant on this site. Primary, secondary, and tertiary flakes were found together with projectile points from a variety of time periods, together with scrapers, hammerstones, and cores. Raw materials include obsidian, rhyolite, chalcedony, quartz, basalt, and latite (Figures 25-32) (see also Appendix B).

Figure 25. Mid-to late Pit Structure period projectile point made of obsidian.

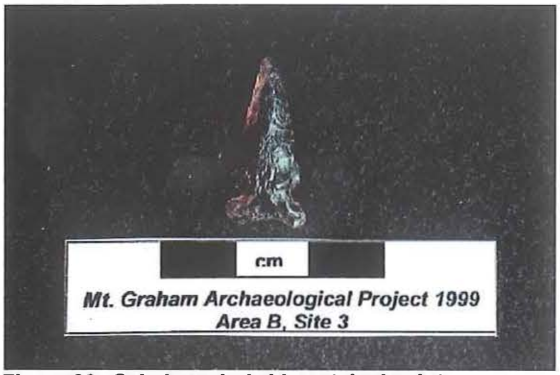


Figure 26. Salado period side-notched point made of obsidian.

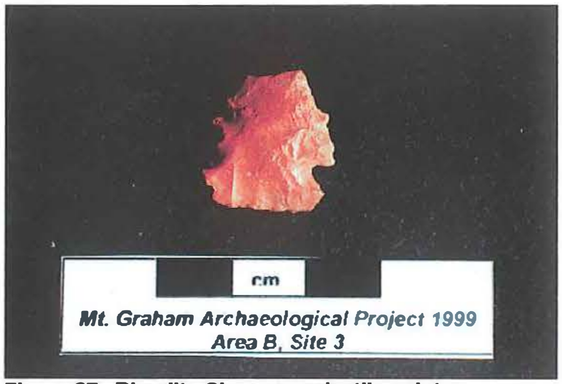


Figure 27. Rhyolite Cienega projectile point.

Figure 28. Cortaro (mid-Archaic) projectile point.

Figure 29. Salado period projectile point (rhyolite).

Figure 30. Bifacial flake tool.

Figure 31. Flake tool (rhyolite).

Figure 32. Hammerstone (basalt), Area B, Site 3.

Ceramics

Potsherds are abundant and dispersed throughout the site. Ware types range from Plain brown, corrugated, corrugated-obliterated, Buff ware, Red ware, White Mountain Red ware, to Mimbres Classic black-on-white, all suggesting that the site was used for an extended period of time (Figures 33-38).

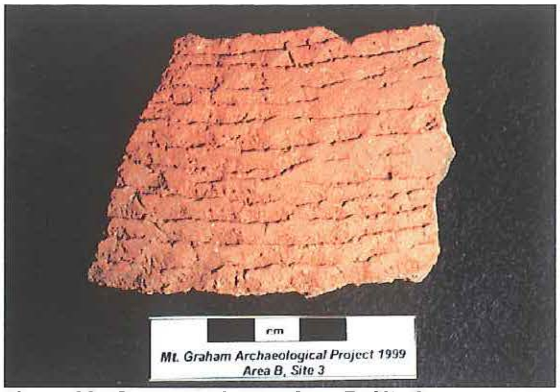


Figure 33. Corrugated ware, Area B, Site 3.

Figure 34. Corrugated rim sherd, Area B, Site 3.

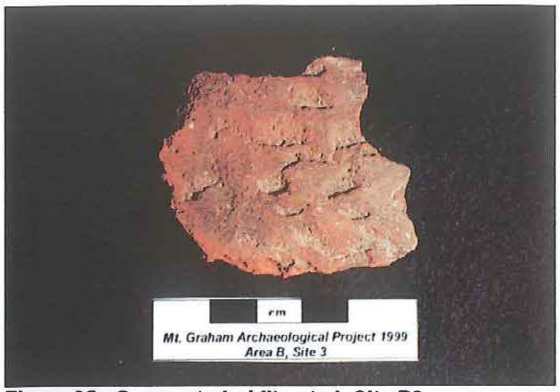


Figure 35. Corrugated-obliterated, Site B3.

Figure 36. Corrugated and plain sherds, B3.

Figure 37. Corrugated sherd, Area B, Site 3.

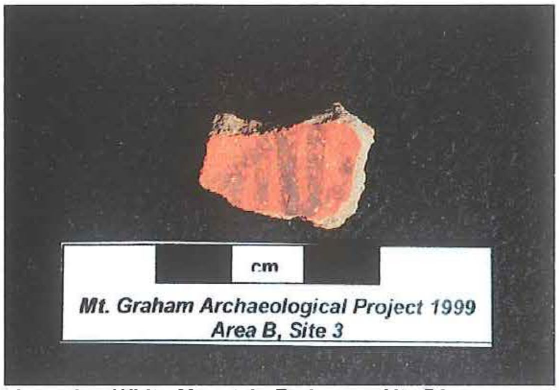


Figure 38. White Mountain Red ware, Site B3.

Groundstone

Manos and metates are present and scattered about the site. Most metates are large, several of a trough type, suggestive of intensive maize processing. We observed manos in a variety of sizes and shapes. Moreover, several very large boulders appear to have been used as makeshift "bedrock" mortars.

Features

A substantial number of agricultural features were observed on this large site. These include check-dams, terraces, field houses, canals (one still carrying water), and what appears to be at least one griddled garden. No hearths were observed in this heavily overgrown area.

General Comments

Research potential is good for the Little Manhattan site. Although the site has been subjected to some scattered erosion, most terraces and water features appear to be intact. We observed several incidences of looting, mainly in and around the field houses. This site is most likely associated with a Pueblo period site that is supposedly situated nearby on BLM property. Each day as we left the survey area we searched for the main Pueblo site, but we never located it. Jacobson Creek and the canal arising from it create the main northern boundary of the site area, although when we walked down into the floodplain we observed several additional water management devices, including check-dams and terraces. The major impediment to research on this site is excessive vegetation. It would be nearly impossible to map the site without first clearing the dense vegetation. A good close-to-ground aerial photograph of the general site area would facilitate mapping, but clearing the vegetation via a controlled burn would probably be most effective.

Discussion

We began this project with several research objectives, all of which relate to the broader question of when the area's prehistoric occupants reduced their movements across the landscape and began to grow more dependent upon agriculture as a means of subsistence. Our first question addressed the issue of whether Late Archaic or Pit Structure period peoples used the lower bajada slopes of Mt. Graham at all. Clearly they did. Site 1 (Rattlesnake Point), located in Area A, looks most like a Late Archaic/Early Pit Structure period limited activity site. Certainly during the Late Archaic and Early Pit Structure periods we would expect to see these areas used on a regular basis given the

abundance of resources on Mt. Graham. We described the site as a probable resource extraction site and the types and numbers of artifacts and structures on the site tend to support this conclusion. However, the season, or seasons, of use cannot be determined without at least some site testing.

Likewise, two of the sites in Area B, the Highpoint and Mano sites, demonstrate that Mt. Graham's bajada slopes were being used fairly intensively during the Middle to Late Pit Structure periods (A.D. 650 to 1050) as well. As with the Rattlesnake Point site in Area A, a question remains as to the season of use. Moreover, we are uncertain at this point whether we are seeing evidence of relatively long-term occupation or evidence of repeated short-term use of the sites. However, the presence of these sites on Mt. Graham's slopes tends to lend credence to Gihnan's (1997) suggestion that during the Pit Structure period (A.D. 100 to 1050) people were moving logistically and, given the presence of several likely pit houses in Area B, possibly making seasonal residential moves as well. Additional research will be required to determine whether this is so.

One final question was whether stone tool evidence would support or refute Lail's (1999) suggestion that people were beginning to decrease their movements across the landscape and to increasingly rely upon agriculture for subsistence during the Late Archaic-to-Pit Structure period transition. However, our collection efforts were biased toward diagnostic artifacts. In order to test Lail's hypothesis we would need to see the entire range of artifacts for comparison. Moreover, we collected only 47 stone artifacts during the entire survey, making the sample size too small to yield to even low-level significance testing. To adequately address this question more data are needed, making excavation of one or more of the bajada sites a necessity.

With regard to stone tools, it is interesting to note that the majority of lithic materials were obtained locally. Even though no known obsidian outcrops occur nearby, obsidian nodules are available in the San Simon drainage (Gilman and Shackley 1999). Several very minor basalt sills are present on Mt. Graham, but the majority of basalt-like materials we found during the survey are in fact latite or latite-basalt and probably came from the Greasewood Mountain Eruptive Center approximately 12 miles due south of the study area.

Occupation during the post-Pit Structure period (after A.D. 1050) was never in question and was not a significant portion of our research focus. However, we recorded and evaluated the Little Manhattan site (Area B, Site 3), concluding that it is a very large Salado period agricultural site probably affiliated with a nearby pueblo.

Conclusion

By conducting the 1999 MGAP survey, we were able to address several important questions, even though our survey only just scratched surface of Mt. Graham's research potential. A tremendous amount of data are available on this large resource-rich mountain, the extraction of which will allow us to make considerable advances in our understanding of the ancient peoples of this region.

Forest Service managers, including professional archaeologists and land management specialists, will benefit from the survey by being able to use our findings to make more informed decisions about how best to use the lands near the sites, and how best to protect the sites themselves. Moreover, our survey contributed to the training of the Coronado National Forest's para-archaeologists, allowing each participating member to gain valuable and necessary experience that will help them better understand,

appreciate, and protect the Forest Service's irreplaceable archaeological resources on Mt. Graham's eastern face.

Appendix A

Recognizing Rock Types in an Archaeological Context

by Warren K .Lail

In this paper I review several very basic principles of geology in order to help archaeologists better identify raw materials in an archaeological context. Stone materials present certain opportunities and constraints depending upon the technological strategy involved. Accordingly, the character, or quality, of the stone is one of its more important attributes. Because the term "quality" is loaded with meaning that may or may not be relevant to a particular tool-making episode, I distinguish materials based upon character, or grain size, and thus avoid the term "quality" when referring to raw materials.

Principles of Geology

Rocks are naturally formed aggregates composed of one or more minerals or mineraloids, glass, or organic particles. They may be identified, in part at least, by examining mineral crystal content. Mineral crystal identification is, in turn, based upon certain observable attributes, including form, color, streak, luster, cleavage planes, fracture surfaces, striations, tenacity, acid-reactivity, magnetism, specific gravity, and hardness. However, mineral properties that can be perceived by the unaided eye are most beneficial for the field identification of rock. Thus, crystal form, color, cleavage and associations are of primary importance for the archaeologist attempting to identify rock specimens in a given assemblage.

Based upon mode of origin, geologists divide rocks into three primary categories: igneous, sedimentary and metamorphic. By considering these origins and their distinct characteristics, archaeologists may improve their identification of given materials. In the following several sections, I briefly discuss the geologic characteristics of rocks in order to demonstrate the importance of those traits to archaeological concerns.

Igneous Rocks

Igneous rocks form when magma cools and hardens, and they fall into two sub-classes; intrusives and extrusives. Extrusive igneous rocks are those that pour out and cool upon the earth's surface. Intrusive igneous rocks form and cool slowly deep within the earth's crust. The most abundant igneous rocks are basalt and granite, although they form in vastly different environments. Igneous rocks that formed during a single time interval have common chemical characteristics, and thus may be distinguishable upon that basis.

The colors of igneous rocks are largely controlled by the colors of the minerals present in them. Rocks rich in magnesium (Mg) and iron (Fe) (the ferromagnesian minerals) tend to contain mafic (dark colored) minerals such as olivine, pyroxene, amphibole,

hornblende, and biotite mica (Ehlers and Blatt 1982:41; Sinkankas 1970:87). On the other hand, rocks rich in silica usually contain an appreciable amount of quartz and light-colored feldspar (Busch, ed. 1993:57).

Igneous rocks are also classified according to texture, or the physical grain-to-grain relationships. If individual mineral grains can be seen with the unaided eye or with the aid of a hand lens, the rock is classified as phaneritic (Ehlers and Blatt 1982:40; Huang 1962:54). The grain of most extrusive igneous rocks is aphanitic (obscure), and is invisible even with a hand lens (Ehlers and Blatt 1982:40; Huang 1962:54). When crystal structure is perceptible, but otherwise too small to recognize, the rock is described as microcrystalline (Huang 1962:54). If all grains are of about equal size, the rock fabric is said to be equigranular (Pirsson 1957:126). If some grains are conspicuously larger than surrounding grains, these are said to be of porphyritic fabric (Huang 1962:55; Pirsson 1957:126). Porphyritic fabric consists of large euhedral crystals called phenocrysts, which are embedded in a finer grained matrix called groundmass (Huang 1962:55; Pirsson 1957:126; Sinkankas 1970:94). Igneous rocks may also contain pockets, or vesicles, which may later become filled with migrating silica (in the form of opal or chalcedony), calcite, zeolite or epidote (Bayly 1968:40).

Extrusive igneous rocks form when magma pours out onto the earth's surface as lava or pyroclastic ash and cools very quickly due to exposure to the earth's atmosphere. When lava cools quickly, ion migration is significantly retarded and mineral crystals have very little time for form. If lava cools rapidly enough no crystals form at all, creating a volcanic glass known as obsidian (Sinkankas 1970:89). Obsidians vary in color from brown to gray to green, but most often are black. Pitchstones are also glassy extrusives, and though duller than the obsidians, are sometimes referred to as "glassy rhyolites" (Huang 1962:170). Pitchstones occur in many colors, including dark gray, brown, red, and green.

Felsites are similar in chemical composition to obsidians, but cool more slowly, allowing for significant growth of small crystals (Sinkankas 1970:92). Felsites are light in color, pale, opaque and so fine in texture that it is difficult to see the separate crystals (Sinkankas 1970:92). Felsite colors range "from pale gray to many shades of red, brown, or even green, but very dark colors are unknown" (Sinkankas 1970:93). Rhyolite is a felsitic rock with phenocrysts of quartz and orthoclase and has the same chemical composition as granite (feldspar, quartz, mica and hornblende) (Huang 1962:123; Sinkankas 1970). Often rhyolites exhibit flow banding or flow structure that can aid in their identification. A felsite whose phenocrysts of plagioclase are in excess of quartz may be dacite (Huang 1962).

Among extrusive igneous rocks, andesite is second only to basalt in relative abundance (Huang 1962: 132). Andesite is hardened lava and may be pale gray or red in color (Sinkankas 1970:95). It differs from other lavas by containing mostly plagioclase feldspar with one of the dark ferromagnesian minerals such as olivine, pyroxene, biotite or hornblende (Huang 1962:132; Sinkankas 1970:95). Andesites are often

porphyritic in texture, weather rapidly and become "brown or reddish-brown upon their surfaces due to the decomposition of the iron-containing dark minerals" (Sinkankas 1970:95). Since many andesites are associated with basalts (Jackson 1970:49), many olivine-bearing andesites are so similar to basalts that they must be subjected to chemical analysis to distinguish them, and are commonly referred to as "basaltic andesite" (Huang 1962:132).

Dacite is the extrusive equivalent of granodiorite (Huang 1962:123). Dacites are typically porphyritic, exhibiting phenocrysts of quartz, orthoclase or sanidine and plagioclase (Huang 1962:123). Though sometimes present, phenocrysts of pyroxene, biotite and hornblende are more rare in dacite. Dacite groundmass is usually glassy or felsitic, and often contains mafic inclusions. "Dacites, together with rhyolite and rhyodacite, are very conspicuous in the lava fields of western North America" (Huang 1962:123).

Basalts are the most abundant of all igneous rocks (Huang 1962:146), and have been extruded in vast quantities from the earliest geologic time to the present (Jackson 1970:43). Basalts are often aphanitic, that is, over half of the crystals cannot be seen by the unaided eye (Pirsson 1957:208), and are typically very dense, heavy and fine-textured (Sinkankas 1970:96). Basalt groundmass is usually dull with a stony appearance. It ranges in color from grayish black, greenish or purplish black to pure black (Pirsson 1957:208; Sinkankas 1970:96). The principal minerals in basalts are mafic, and include gray (calcic) plagioclase, black pyroxene, augite, iron oxides and some accessory olivine and magnetite (Huang 1962:146; Sinkankas 1970:96). Though most basalts are fine-grained, some may be porphyritic and contain crystals of olivine, augite, plagioclase, hornblende or biotite (Huang 1962:146; Sinkankas 1970:96). In addition, some basalts contain "round or oval gas cavities (vesicles) in otherwise solid rock and are then called amygdaloidal basalts" (Sinkankas 1970:98). Openings in amygdaloidal basalts are often filled with chalcedony and amethyst (Sinkankas 1970:98). Basalts also occur in a variety of textures, and are usually given different names to help distinguish them. The term "basalt" proper is typically reserved for the fine-grained materials of basaltic composition (Bayly 1968:40; Pirsson 1957:208).

Intrusive igneous rocks form when magma squeezes its way into cracks or crevices in already solidified rocks and cools more slowly (Sinkankas 1970:86). Intrusive igneous rocks share most chemical and mineralogical attributes with extrusives, but the slower rate of cooling results in the development of much coarser grain and the growth of larger mineral crystals, making them less favored for stone tool making in prehistory.

Sedimentary Rocks

Sedimentary rocks are those rocks that form from sediments freed up from existing rocks (Huang 1962:211; Sinkankas 1970:104). Sediments are solid fragments that originate from the weathering of rocks, whether by chemical or mechanical processes, but usually both processes are at work (Jackson 1970:103). After breaking down, sediments are carried away by water, wind, or ice, and are later deposited, layer

after layer, in a stratified fashion (Huang 1962:211; Jackson 1970:83; Pirsson 1957; Sinkankas 1970:211). Following deposition, the sediments are lithified, or turned into rock, at relatively low temperatures, and may accumulate to thousands of feet in thickness (Huang 1962:211). Sandstone is an example of sedimentary rock that forms from beds of sand in which the individual particles are firmly cemented together with calcite, quartz, iron oxides or several mixtures of these minerals (Sinkankas 1970:112). Some sandstones become so indurated that they are called orthoquartzites, or "quartzitic sandstone," and have fracture properties quite similar to true quartzites (metaquartzites).

Opal is derived from non-crystalline amorphous masses of silica and contains variable quantities of water. Opals form primarily as deposited liquids containing colloidal silica in a gelatinous state. As opal dehydrates it may crystallize, forming what is commonly referred to as chalcedony (Pirsson 1957:67). Chalcedony is therefore a fibrous and microfibrous form of quartz "in which fibers have grown in the direction of the lateral crystallographic axes instead of the vertical axis as in normal quartz." (Pirsson 1957:67-68). Chalcedony is usually waxy in appearance, is generally spherulitic, and occurs in botayoidal and mammillary masses, demonstrating its colloform ancestry when it was deposited as gelatinous silica (Pirsson 1957:68).

Cherts and flints are aphanitic rocks composed of cryptocrystalline silica or opal, or both (Pirsson 1957:273). Cherts that contain appreciable quantities of iron oxide are often referred to as jasper (Sinkankas 1970:121). Jasper is a common name often used to describe red or reddish-brown chert, and some jaspers are "interlaminated" with layers or streaks of hematite (Pirsson 1957:274).

Metamorphic Rocks

Metamorphic rocks are formed by the structural and mineralogical transformation of existing rocks by heat, pressure and chemical action below the zone of cementation and weathering (Jackson 1970:181). The dividing line between metamorphic and non-metamorphic rocks is usually drawn at the point where a rock is subjected to enough heat, pressure, and chemical activity "to cause the original minerals to recrystallize and new minerals to form" (Sinkankas 1970:125).

Quartzite is a firm and compact highly metamorphosed sandstone composed of tightly packed quartz grains. During the process of metamorphism, the pores, or interstices between the crystals, are filled with quartz (Sinkankas 1970:132). The rock becomes dense, tough and uniform in texture. "Pure [quartzites] show shining fracture surfaces which pass through grains of sand instead of going around them as would be the case in unmetamorphosed sandstones or conglomerates. Less strongly compacted quartzites are decidedly grainy upon fracture surfaces" (Sinkankas 1970:132).

Under the right conditions, all rocks are subject to metamorphism. For example, when basalt containing high quantities of chlorite and epidote undergoes metamorphosis, it often produces a meta-volcanic known as *greenstone* (Nations and Stump 1981). Greenstone was used and traded widely

in prehistory, with some specimens making their way from the volcanic regions of the North American Southwest as far east as Oklahoma (Brosowske and Bement 1998).

The Importance of Geologic Principles to Archaeologists

Archaeologists working with stone artifacts of any description will benefit from a basic understanding of geology. Petrology is a complex subject; this is especially true of igneous petrology. However, if we wish to understand how and where rocks were formed and how humans have manipulated them as tools throughout prehistory, we must embark upon this study.

The flaking characteristics of available stone materials vary widely. At one end of the continuum we find the non-crystalline volcanic glass, or obsidian, and at the other, the bubbly, extraordinarily porous and non-knappable gabbro and scoria. In between we find the cryptocrystalline-to-microcrystalline felsites, cryptocrystalline cherts and chalcedonies, the very-fine-to-sugary-textured quartzites, and finally, the macrocrystalline granitic materials. In general, those raw materials that are suitable for tool-making possess certain characteristics relative to the technological strategy involved. Subsistence strategies that involve mobility generally require light, transportable, easily maintainable tools (Bleed 1986) that are often made from non-crystalline, microcrystalline or cryptocrystalline materials. All of the glassy igneous varieties – obsidian, pitchstone, and vitrophyre – would qualify as highly knappable, easily maintainable materials. However, they all share a common inadequacy; they are all very brittle, thus easily damaged, and must be resharpened often. Some of the felsitic igneous rocks are also suitable for a mobile technology, including the fine-grained rhyolites. In many instances, the very fine textured, highly meta-morphosed quartzites make superb tool-stone because they seem to strike a balance between maintainability and durability. Finally, tools for processing plants and woody materials need to be durable (Bleed 1986), and quartzites and medium-to-coarse grained extrusive volcanics make excellent choices.

Conclusion

By examining stone tools with the geologic characteristics of raw materials in mind, we should be able to make more informed inferences about the technological strategies involved in any given archaeological context. Indeed, without a good understanding of geology many sources of inference will elude us.

We are all subject to err when trying to identify rock types. We frequently turn to other archaeologists for help in identifying raw materials from a given locality. A better practice would be for archaeologists to take the time to learn the true geologic characteristics of materials within their study areas. The best practice, however, in order to accurately identify the raw materials in a particular assemblage, is to consult a geologist.

Accurate identification of some rock specimens by visual inspection alone is often a daunting task. For example, the composition of extrusive igneous rocks rests on a chemical continuum. Based upon chemical and mineral makeup, basalt grades into latite

or andesite, andesite grades into latite or dacite, and dacite grades into rhyodacite or rhyolite. While it is relatively easy to distinguish basalt and rhyolite, it becomes somewhat more difficult, for example, to distinguish chemically similar basalts and latites. When we see the mineral crystals olivine or pyroxene, they always suggest basalt, as does iddingsite (an alteration product of olivine). However, tiny splinters of calcic plagioclase in a glassy groundmass otherwise nearly devoid of mineral crystals, strongly suggests that the material is latite, or trachybasalt. Even making these distinctions presupposes that the tiny crystals in the groundmass are perceptible *and* identifiable. Among geologists debates regarding material type and origin are not uncommon, so we should expect similar debates among archaeologists as well. However, geologists settle their disputes with thin-section and geochemical analyses that reduce questions of material type and origin to a certainty. When in doubt, consult a geologist with expertise in your study area.

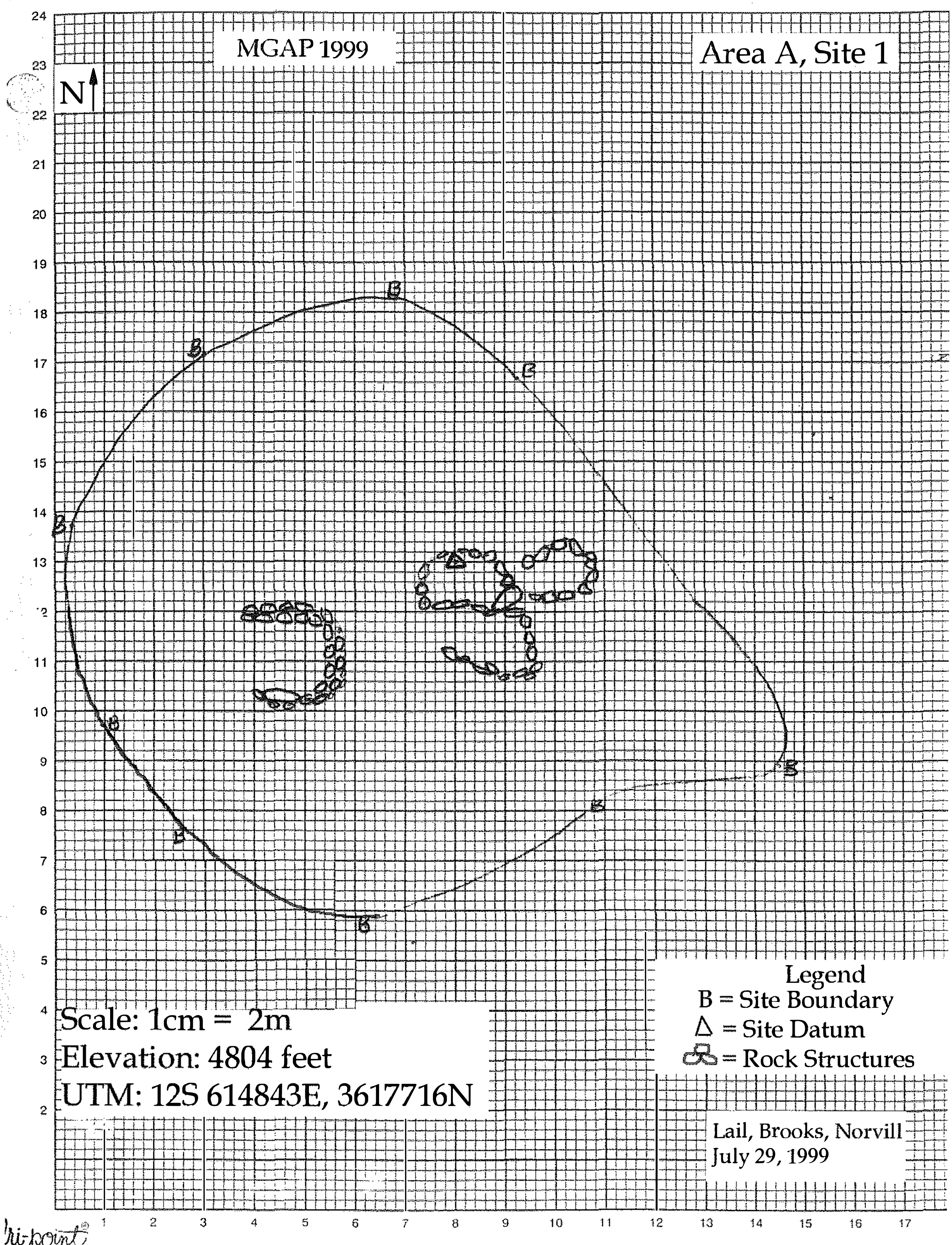
Appendix B: Raw Data

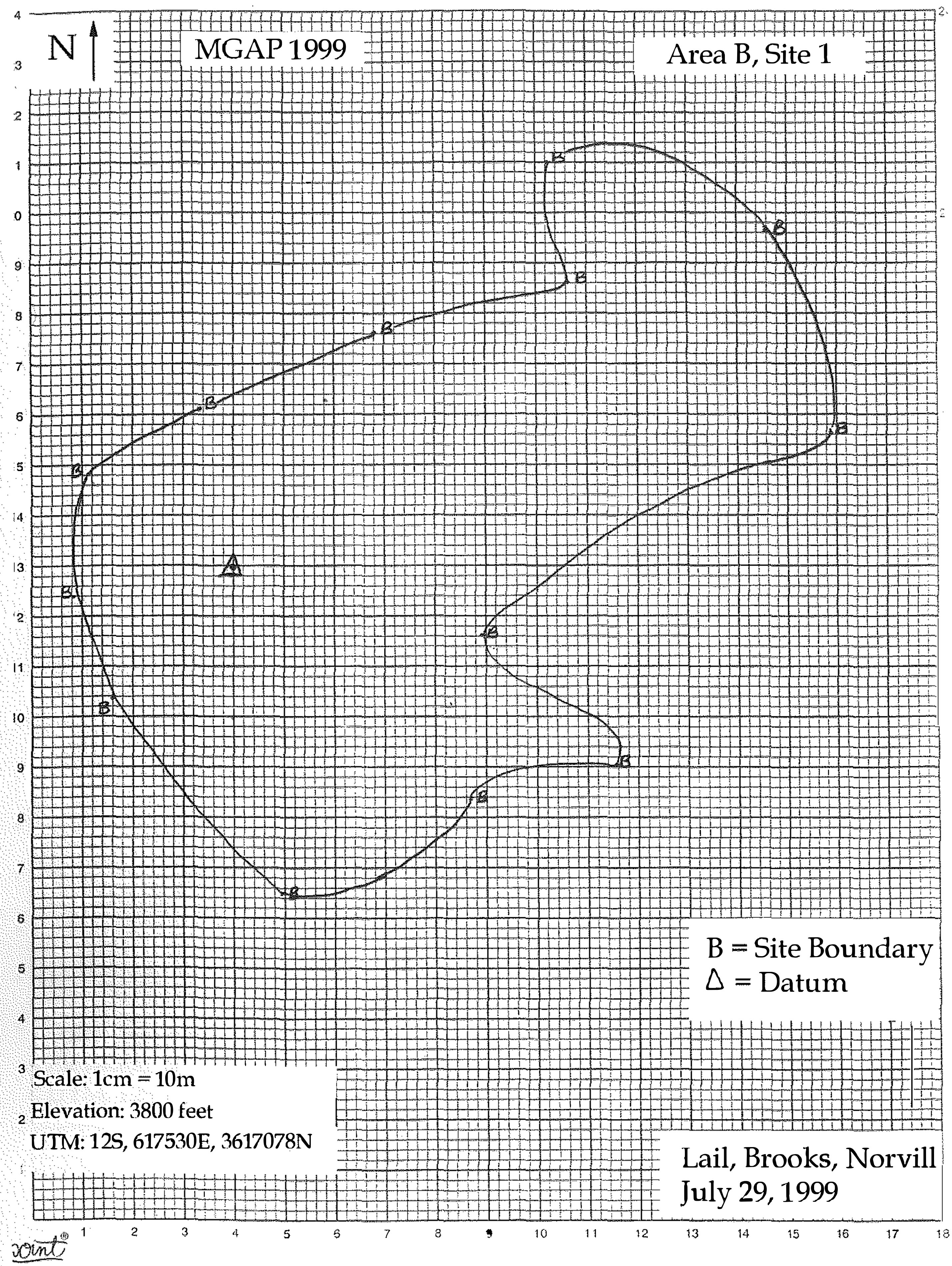
Area	SiteNumber	FS#	Easting	Northing	Level	Material	Object	Quantity	Style (sherds)	Analyst(s)
A	1	66	614843	3617716	Surface	fired clay	jar rim	1	corrugated	W. Lail, P. Gilman
A	1	61	614915	3617716	Surface	latite	margin retouch uniface	1		W. Lail, N. Suneson
A	1	60	614915	3617716	Surface	obsidian	projectile point	1		W. Lail, N. Suneson
A	1	59	614920	3617604	Surface	rhyolite	projectile point	1		W. Lail, N. Suneson
A	1	66	614843	3617716	Surface	fired clay	sherd, indeterminate form	6	Plain ware	W. Lail, P. Gilman
A	1	61	614915	3617716	Surface	latite	tertiary flake	1		W. Lail, N. Suneson
A	1	61	614915	3617716	Surface	obsidian	tertiary flake	1		W. Lail, N. Suneson
B	1	15	617599	3617061	Surface	fired clay	bowl rim	2	Mimbres classic	W. Lail, P. Gilman
B	1	15	617599	3617061	Surface	fired clay	bowl sherd	2	Mimbres classic	W. Lail, P. Gilman
B	1	15	617599	3617061	Surface	fired clay	bowl sherd	2	Mimbres indeterminate	W. Lail, P. Gilman
B	1	15	617599	3617061	Surface	fired clay	bowl sherd	2	Mimbres truly indeterminate	W. Lail, P. Gilman
B	1	15	617599	3617061	Surface	fired clay	bowl sherd	5	Encinas red on brown	W. Lail, P. Gilman
B	1	15	617599	3617061	Surface	fired clay	bowl sherd	2	Pinaleno red on brown	W. Lail, P. Gilman
B	1	15	617599	3617061	Surface	fired clay	bowl sherd	1	Black on red	W. Lail, P. Gilman
B	1	65	122m east of datum		Surface	chalcedony	facial retouch biface	1		W. Lail, N. Suneson
B	1	15	617599	3617061	Surface	fired clay	jar sherd	1	Sacaton red on buff	W. Lail, P. Gilman
B	1	15	617599	3617061	Surface	fired clay	jar sherd	1	Red ware	W. Lail, P. Gilman
B	1	1	617341	3616979	Surface	n/a	non-artifact	1		W. Lail, N. Suneson
B	1	16	617599	3617061	Surface	fired clay	sherd, indeterminate form	5	Plain ware	W. Lail, P. Gilman
B	1	63	617609	3617065	Surface	basalt	tertiary flake	1		W. Lail, N. Suneson
B	2	62	617471	3616920	Surface	rhyolite	margin retouch uniface	1		W. Lail, N. Suneson
B	2	7	617471	3616920	Surface	fired clay	sherd, indeterminate form	9	Incised	W. Lail, P. Gilman
B	2	10	617471	3616920	Surface	fired clay	sherd, indeterminate form	2	Plain ware	W. Lail, P. Gilman
B	3	50	616666	3617071	Surface	fired clay	bowl rim	1	Mimbes classic	W. Lail, P. Gilman
B	3	46	617065	3617186	Surface	fired clay	bowl sherd	1	Redware	W. Lail, P. Gilman
B	3	54	617165	3617246	Surface	fired clay	bowl sherd	1	White Mtn. Red ware	W. Lail, P. Gilman
B	3	57	616678	3617074	Surface	dacite	core	1		W. Lail, N. Suneson
B	3	13	616635	3617098	Surface	latite	core	1		W. Lail, N. Suneson
B	3	44	616988	3617136	Surface	latite	core	1		W. Lail, N. Suneson
B	3	12	616876	3617170	Surface	latite	facial retouch biface	1		W. Lail, N. Suneson
B	3	24	616906	3616833	Surface	chalcedony	facial retouch uniface	1		W. Lail, N. Suneson
B	3	48	617114	3617046	Surface	basalt	hammerstone	1		W. Lail, N. Suneson
B	3	38	616341	3616979	Surface	fired clay	jar rim	1	corrugated	W. Lail, P. Gilman

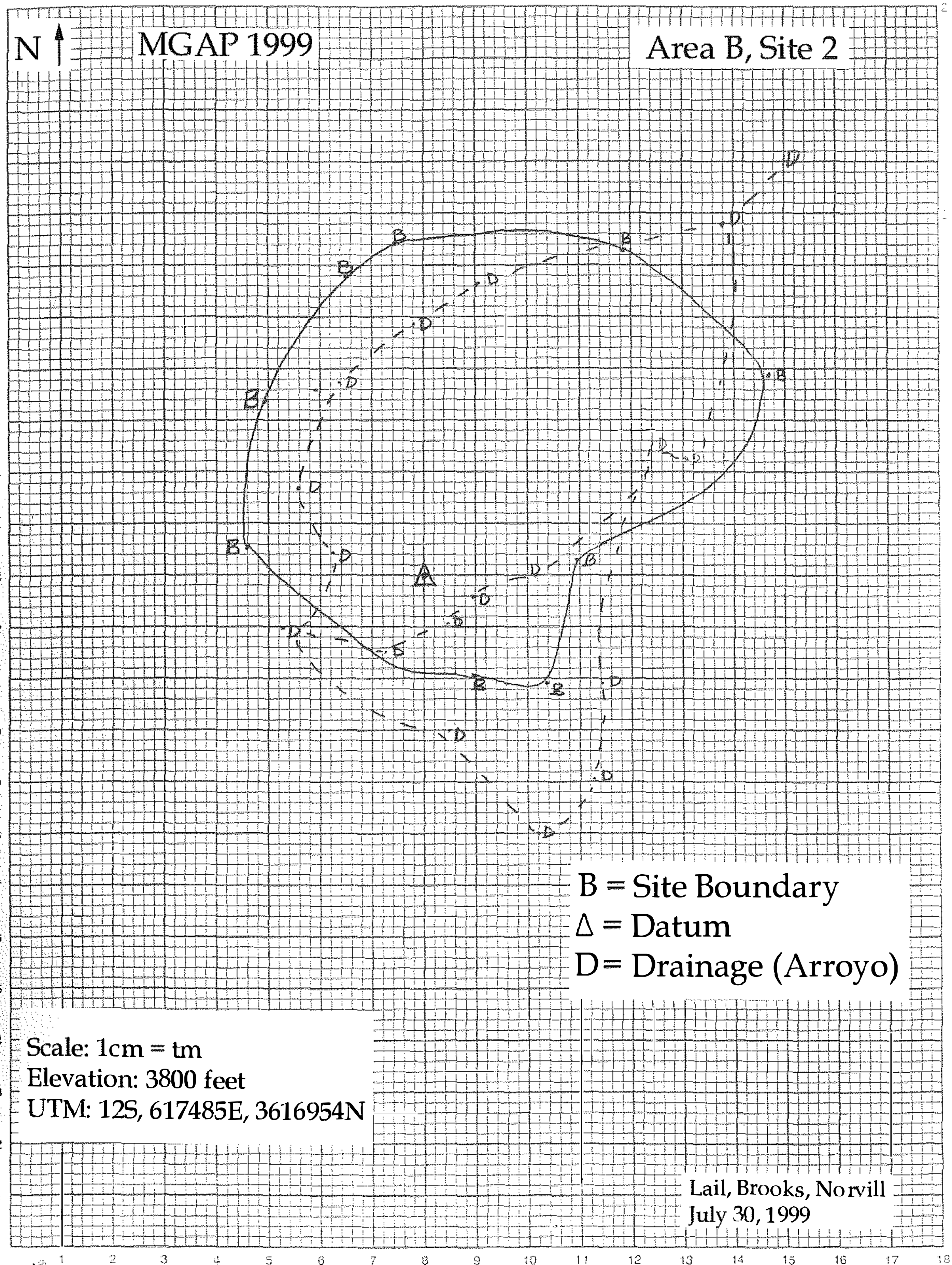
Area	SiteNumber	FS#	Easting	Northing	Level	Material	Object	Quantity	Style (sherds)	Analyst(s)
B	3	23	616647	3617077	Surface	fired clay	jar rim	1	Buff ware	W. Lail, P. Gilman
B	3	28	616647	3617077	Surface	fired clay	jar rim	1	Buff ware	W. Lail, P. Gilman
B	3	21	616869	3617113	Surface	fired clay	jar rim	1	Plain ware	W. Lail, P. Gilman
B	3	33	616869	3617113	Surface	fired clay	jar rim	1	Plain ware	W. Lail, P. Gilman
B	3	40	616869	3617113	Surface	fired clay	jar sherd	1	Mimbes indeterminate	W. Lail, P. Gilman
B	3	18	616793	3617088	Surface	chalcedony	margin retouch biface	1		W. Lail, N. Suneson
B	3	25	617143	3616983	Surface	latite	margin retouch biface	1		W. Lail, N. Suneson
B	3	26	616356	3616924	Surface	chalcedony	margin retouch uniface	1		W. Lail, N. Suneson
B	3	52	616697	3617098	Surface	chalcedony	margin retouch uniface	1		W. Lail, N. Suneson
B	3	58	616931	3617134	Surface	chalcedony	margin retouch uniface	1		W. Lail, N. Suneson
B	3	9	616962	3617109	Surface	chalcedony	margin retouch uniface	1		W. Lail, N. Suneson
B	3	2	616678	3617074	Surface	latite	margin retouch uniface	1		W. Lail, N. Suneson
B	3	29	616965	3617164	Surface	latite	margin retouch uniface	1		W. Lail, N. Suneson
B	3	45	617674	3617081	Surface	obsidian	margin retouch uniface	1		W. Lail, N. Suneson
B	3	47	616795	3617121	Surface	rhyolite	margin retouch uniface	1		W. Lail, N. Suneson
B	3	27	616693	3617124	Surface	rhyolite	margin retouch uniface	1		W. Lail, N. Suneson
B	3	3	616816	3617130	Surface	rhyolite	margin retouch uniface	1		W. Lail, N. Suneson
B	3	8	616692	3617109	Surface	quartz	margin retouch uniface	1		W. Lail, N. Suneson
B	3	56	616931	3617134	Surface	quartz	margin retouch uniface	1		W. Lail, N. Suneson
B	3	49	616869	3617113	Surface	unidentified	margin retouch uniface	1		W. Lail, N. Suneson
B	3	14	617122	3617143	Surface	n/a	non-artifact	1		W. Lail, N. Suneson
B	3	41	616495	3616763	Surface	obsidian	projectile point	1		W. Lail, N. Suneson
B	3	30	616567	3617099	Surface	obsidian	projectile point	1		W. Lail, N. Suneson
B	3	35	616672	3617077	Surface	rhyolite	projectile point	1		W. Lail, N. Suneson
B	3	31	616765	3617139	Surface	rhyolite	projectile point	1		W. Lail, N. Suneson
B	3	39	616887	3617072	Surface	rhyolite	projectile point	1		W. Lail, N. Suneson
B	3	22	616869	3617124	Surface	rhyolite	projectile point	1		W. Lail, N. Suneson
B	3	34	616994	3617118	Surface	obsidian	secondary flake	1		W. Lail, N. Suneson
B	3	38	616341	3616979	Surface	fired clay	sherd, indeterminate form	1	corrugated	W. Lail, P. Gilman
B	3	38	616341	3616979	Surface	fired clay	sherd, indeterminate form	1	corrugated	W. Lail, P. Gilman
B	3	38	616341	3616979	Surface	fired clay	sherd, indeterminate form	1	Plain ware	W. Lail, P. Gilman
B	3	42	616341	3616979	Surface	fired clay	sherd, indeterminate form	1	corrugated-obliterated (2pcs)	W. Lail, P. Gilman
B	3	42	616341	3616979	Surface	fired clay	sherd, indeterminate form	1	Plain ware	W. Lail, P. Gilman

Area	SiteNumber	FS#	Easting	Northing	Level	Material	Object	Quantity	Style (sherds)	Analyst(s)
B	3	37	616382	3616906	Surface	fired clay	sherd, indeterminate form	1	corrugated	W. Lail, P. Gilman
B	3	36	616666	3617071	Surface	fired clay	sherd, indeterminate form	1	corrugated	W. Lail, P. Gilman
B	3	53	616470	3616910	Surface	basalt/latite	tertiary flake	1		W. Lail, N. Suneson
B	3	5	616629	3617081	Surface	chalcedony	tertiary flake	1		W. Lail, N. Suneson
B	3	32	616869	3617129	Surface	chert	tertiary flake	1		W. Lail, N. Suneson
B	3	55	616906	3616834	Surface	dacite	tertiary flake	1		W. Lail, N. Suneson
B	3	43	616629	3617081	Surface	latite	tertiary flake	1		W. Lail, N. Suneson
B	3	6	616869	3617151	Surface	obsidian	tertiary flake	1		W. Lail, N. Suneson
B	3	17	616693	3617124	Surface	quartzite	tertiary flake	1		W. Lail, N. Suneson
B	3	11	616962	3617109	Surface	quartzite	tertiary flake	1		W. Lail, N. Suneson
B	3	51	616669	3617141	Surface	unidentified	tertiary flake	1		W. Lail, N. Suneson
B	3	4	616616	3617078	Surface	dacite	tertiary flake	1		W. Lail, N. Suneson
D	I.O.	64	617086	3616264	Surface	obsidian	margin retouch uniface	1		W. Lail, N. Suneson
D	I.O.	20	617099	3616352	Surface	obsidian	secondary flake	1		W. Lail, N. Suneson

Appendix C: Site Maps


MGAP 1999
Area A, Site 1
N
B
Legend
B = Site Boundary
Δ = Site Datum
= Rock Structures
Scale: 1cm = 2m
Elevation: 4804 feet
UTM: 12S 614843E, 3617716N
Lail, Brooks, Norvill
July 29, 1999
Tri-point


N
MGAP 1999
Area B, Site 1
B
Δ
B = Site Boundary
Δ = Datum
Scale: 1cm = 10m
Elevation: 3800 feet
UTM: 12S, 617530E, 3617078N
Lail, Brooks, Norvill
July 29, 1999



N
MGAP 1999
Area B, Site 2
B = Site Boundary
Δ = Datum
D= Drainage (Arroyo)
Scale: 1cm = tm
Elevation: 3800 feet
UTM: 12S, 617485E, 3616954N
Lail, Brooks, Norvill
July 30, 1999

References Cited

Alexander, J.
1977 The Frontier Concept in Prehistory: The End of the Moving Frontier. In *Hunters, Gatherers, and First Farmers Beyond Europe*, edited by J.V.S. Megaw, pp. 25-40. Leicester University Press, Leicester, England.

Bayly, B.
1968 *Introduction to Petrology*. Prentice-Hall. New Jersey.

Bleed, P.
1986 The Optimal Design of Hunting Weapons: Maintainability and Reliability. *American Antiquity* 51:737-747.

Bronitsky, G., and J.D. Merritt
1986 *The Archaeology of Southeast Arizona: A Class I Cultural Resource Inventory*. Bureau of Land Management, Phoenix.

Brosowske, S.D., and L.C. Bement
1998 Plains Interaction During the Late Prehistoric: A View from Some New Sites in the Oklahoma Panhandle. A paper presented at the 56th annual Plains Anthropological Conference, Bismarck, North Dakota.

Brown, D.E., editor
1994 *Biotic Communities: Southwestern United States and Northwestern Mexico.* University of Utah Press, Salt Lake City.

Busch, R.M., editor
1993 *Laboratory Manual in Physical Geology* (3rd edition). Macmillan Publishing Company, New York.

Cooley, M.E., editor
1967 *Arizona Highway Geologic Map*. Arizona Geological Survey, Tucson.

Dobres, M.A., and C.R. Hoffman
1994 Social Agency and the Dynamics of Prehistoric Technology. *Journal of Archaeological Method and Theory* 1(3):211-259.

Dobyns, H.F.
1981 *From Fire to Flood: Historic Human Destruction of Sonoran Desert Riverine Oases.* Ballena Press Anthropological Papers No. 20. Socorro, New Mexico.

Earle, T.K.
1980 A Model of Subsistence Change. In *Modeling Change in Prehistoric Subsistence Economies*, edited by T.K. Earle and A.L. Christenson. Academic Press, New York.

Ehlers, Ernest G. and Harvey Blatt
1982 *Petrology: Igneous, Sedimentary and Metamorphic.* W.H. Freeman and Co. San Francisco.

Fish, S.K., P.R. Fish, and J. Madsen
1992 *The Marana Community in the Hohokam World.* Anthropological Papers of the University of Arizona No. 56. The University of Arizona Press, Tucson.

Flannery, K.V.
1972 The Origins of the Village as a Settlement Type in Mesoamerica and the Near East: A Comparative Study. In *Man, Settlement and Urbanism*, edited by P.Ucko, R. Tringham and G.W. Dimbleby, pp. 321-336. Duckworth and Co., London.

Forrester, J.D.
1959 *Geologic Map of Cochise County, Arizona.* Arizona Bureau of Mines, Tucson.

Gilman, P.A.
1987 Architecture As Artifact: Pit Structures and Pueblos in the American Southwest. *American Antiquity* 53:538-564.

1989 *The Archaeological Survey in the San Simon Drainage.* Office of Cultural Resource Management Report No. 73. Arizona State University, Tempe.

1992 Field Notes for the San Simon Archaeological Project Excavations in the Parks Lake Region, 1992. On file at the Arizona State Museum, Tucson.

1995 Multiple Dimensions of the Archaic-to-Pit Structure Period Transition in Southeastern Arizona. *Kiva* 60:619-632.

1997 *Wandering Villagers: Pit Structures, Mobility, and Agriculture in Southeastern Arizona.* Anthropological Research Papers No. 49. Arizona State University Press, Tempe, Arizona.

1998 Variations in Agricultural Dependence and Residential Mobility During The Pit Structure Period: What Do They Mean? Manuscript on file, Department of Anthropology, University of Oklahoma.

Gilman, P.A., and M.S. Shackley
1999 The Temporal Structure of Obsidian Availability and its Use in Southeastern Arizona. Manuscript on file, Department of Anthropology, University of Oklahoma.

Houser, B.B., D.H. Richter, and M. Shafiqullah
1985 *Geologic Map of the Safford Quadrangle, Graham County, Arizona.* United States Geological Survey (USGS), Map I-1617.

Huang, W. T.
1962 *Petrology.* McGraw-Hill, New York.

Jackson, Kern C.
1970 *Textbook of Lithology.* McGraw-Hill. New York.

Lail, W.K.
1999 Stone Tools, Mobility, and Agricultural Dependence in Southeastern Arizona. Unpublished M.A. thesis. Department of Anthropology, University of Oklahoma, Norman.

Minnis, P.E.
1992 Earliest Plant Cultivation in the Desert Borderlands of North America. In *The Origins of Agriculture: An International Perspective*, edited by C.W. Cowan and P.J. Watson, pp. 121-141. Smithsonian Institution Press, Washington.

Mitchell, R.S.
1985 *Dictionary of Rocks.* Van Nostrand-Reinhold, New York.

Nations, D., and E. Stump
1981 *Geology of Arizona.* Kendall/Hunt, Dubuque.

Parry, W.J., and R.L. Kelly
1987 Expedient Core Technology and Sedentism. In *The Organization of Core Technology*, edited by J.K. Johnson and C.A. Morrow, pp. 285-304. Westview Press, Boulder.

Pirsson, Louis V.
1957 *Rocks and Rock Minerals.* John Wiley & Sons. New York.

Reynolds, S.J.
1988 *Geologic Map of Arizona.* United States Geological Survey, Map 26.

Sinkankas, John
1970 *Prospecting for Gemstones and Minerals.* (2nd edition). Van Nostrand-Reinhold. New York

Sliva, R.J.
1997 *Introduction to the Study and Analysis of Flaked Stone Artifacts and Lithic Technology.* Center for Desert Archaeology, Tucson.

Tainter, J.A.
1996 Introduction: Prehistoric Societies as Evolving Complex Systems. In *Evolving Complexity and Environmental Risk in the Prehistoric Southwest*, edited by J.A. Tainter and B.B. Tainter, pp. 1-23. Addison-Wesley Publishing Company, Reading, Massachusetts.

Wills, W.H.
1992 Plant Cultivation and the Evolution of Risk-Prone Economies in the Prehistoric American Southwest. In *Transitions to Agriculture in Prehistory*, edited by A.B. Gebauer and T.D. Price, pp. 153-176. Monographs in World Archaeology No. 4. Prehistory Press, Madison, Wisconsin.

Wills, W.H., and B.B. Huckell
1994 Economic Implications of Changing Land-Use Patterns in the Late Archaic. In *Themes in Southwest Prehistory,* edited by G.J. Gumerman, pp. 32-52. School of American Research Press, Santa Fe.